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The purpose of this project was to compare the costs and benefits of manufacturing shirts on the bundle system an d a modular system, as well as installation of a modular system at the CAR demonstration facility.

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Short Term Task

Final Report

FLEXIBLE WORK GROUPS

by

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November 7, 1994

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FLEXIBLE WORK GROUPS

1.0 Introduction

1.1 Overview and Problem Description

It is quite clear today that the niche for the United States apparel manufacturing industry is in the production of high quality goods and the ability to do so with ever decreasing lead times. With wage rates in Far Eastern and some Central American countries of less than $1.00 per hour, it is virtually impossible for the United States apparel manufacturer to compete on cost effectiveness alone. The United States apparel manufacturing industry must find new ways to produce the goods in order to be competitive in quality and timely deliveries of the product. Flexible Manufacturing Systems have become popular in the last decade due to their ability to meet those objectives. The two most common applications of Flexible Manufacturing Systems in the United States apparel industry are Unit Production Systems and Flexible Work Groups. This paper will define each of these systems and will concentrate on the specifics of Flexible Work Groups (FWG) including details of successful applications, compensation options and steps to success. Recognizing the need to revitalize the US apparel industry to meet both strategic and economic needs of the DOD, the Defense Logistics Agency funded research on Flexible Manufacturing Systems employed in some US and Japanese apparel manufacturing firms. The study included implementation of FWG in the Clemson Apparel Research (CAR) demonstration facility producing US Army AG415 shirts as well as several commercial items.

1.2 History of FWG in Apparel

Even though Flexible Manufacturing Systems have been available to the United States apparel industry for many decades, the concepts have not been widely utilized. The primary reason for this situation is that the objectives of the United States apparel industry in the years following World War II and through the early 1970's were centered around the need to increase productivity. The world apparel manufacturing market was such that very few countries were capable of meeting the United States retail market demands and transportation systems did not exist that would allow the goods to be shipped to the United States market from various points around the world. Further, effective worldwide communication systems did not exist that would allow United States retailers and manufacturers to effectively communicate with overseas production

facilities. Most importantly, during those years the United States apparel industry, like many other United States industries, had an admirable reputation for quality and overall productivity capacities. Today, all of these points have drastically changed.

Beginning in earnest in the early 1970's and continuing through today, apparel manufacturers in the Far East and other parts of the world have developed the manufacturing capabilities to meet the United States retail market demand. Transportation and communication technologies have been developed that will allow the goods to be transported efficiently and quickly from remote parts of the globe. Paragraph 807 of the United States Tariff Code has been exploited by United States retailers and contracting manufacturers such that goods can be produced in Caribbean and Central American countries, then transported back to the United States market at prices much lower than goods produced on United States soil. In addition, the quality reputation of United States apparel manufacturers has declined while the quality capability of foreign manufacturers has improved. All of these factors combined have resulted in a reduction in the competitiveness of the United States apparel manufacturing industry.

Therefore, Flexible Manufacturing Systems have been looked upon as one of the solutions to this lack of competitiveness. In both cases, the Flexible Work Group and Unit Production System concepts require a significant change in management style as work-in-process levels are reduced. While many variations exist in the actual implementation of Flexible Manufacturing Systems, all involve drastic reductions in work-in-process levels resulting in faster throughput times. In addition, other benefits have been realized including improved quality levels, improved attendance and turnover statistics and reduced space utilization.

It is important to note at the outset that Flexible Work Groups and Unit Production Systems are not competing alternatives. In fact, the Unit Production System may well be considered a mechanization of the Flexible Work Group concept. In implementing a Flexible Work Group, management procedures must adapt to the reduced work-in-process levels by assuring that machinery, systems and work schedules are properly administered for immediate response to routine work flow constraints. This same principle applies to the installation of a Unit Production System.

Typically, a Flexible Work Group installation includes some level of employee empowerment allowing the production workers to make some or all of the decisions regarding the performance of the task. This is not typically true in the installation of Unit Production System and is

considered to be the primary difference in management concepts employed in the two systems. As will be discussed, instituting employee involvement/empowerment programs within a Unit Production System may offer the best of all worlds.

1.3 Scope of the Project

The remainder of this paper will discuss statistics and information gathered by Clemson Apparel Research, Clemson University, Clemson, SC, on independent studies investigating the cost and benefits of Flexible Work Groups in relation to the Progressive Bundle System which is the most common production control system used by United States apparel plants. This study was funded by the Defense Logistics Agency for the United States Department of Defense. The paper will conclude with a conclusion of how FWG's may be most effectively implemented in US apparel manufacturing plants.

2.0 Flexible Work Group Definitions

A recent innovation in United States apparel production is the Flexible Work Group. While it is referred to by many names including modular manufacturing, compact production teams, self-directed work teams and cellular manufacturing, the basic concept is one that originated in the United States, was embraced and refined by the Japanese, and was only recently rediscovered in the United States. The concept evolved from the original line system for apparel production that was discarded over 20 years ago. Flexible Work Groups will be the term most often used in this paper, but Modular Manufacturing is the name typically assigned by the United States apparel industry and will be used occasionally in the paper.

While most United States apparel machinery and systems are easily defined, this is not true with the Flexible Work Group concept. The following definition is considered to be complete and yet general enough to allow for the infinite variations that exist in FWG installations throughout the US. It was developed as a result of visits to dozens of manufacturing plants in the US and Japan.:

2.1 Clemson Apparel Research Definition of FWG

A Flexible Work Group is a *management concept* involving a team of apparel associates with variations of the following characteristics:

- Continual training in problem solving techniques, brainstorming, effective communication, basic engineering, costing, scheduling, preventative maintenance, line balancing, ergonomics, conflict resolution, quality principles, safety principles, etc.

- Encouraged employee involvement; regular team meetings, authority to make all decisions involving the performance of the task

- Minimal supervision and service provided

- Paid as a team rather than as individuals

- Encouraged cross training - highly flexible

- Responsible for total quality performance
- (cleaning, re-cutting)

- Maintaining very low work-in-process levels to achieve Quick Response and using the "pull" system of production flow control

- Equipment arranged so that work can be passed from one team member to the next

The Flexible Work Group is a management concept and reasonable variations within each of the categories above does not change the basic philosophy.

Dr. W. Edwards Deming, who is credited with the Japanese method of management that many United States industries are trying to emulate, developed fourteen points of management that are the cornerstone of the Flexible Work Group concept. Those points are listed in the appendix of this paper. Other definitions which are relative to the Flexible Work Group concept follow.

2.2 Apparel Research Committee of AAMA Definition

Flexible Work Groups - "A contained, manageable work unit of five to seventeen people performing a measurable task. The operators are interchangeable among tasks within the group to the extent practical and incentive compensation is based upon the team's output of first quality product." (AAMA, Apparel Research Committee Flexible Manufacturing Systems Subcommittee, 1988)

2.3 Flexible Manufacturing

Flexible Manufacturing - "Any departure from traditional mass production systems of apparel toward faster, smaller, more flexible production units that depend upon the coordinated efforts of minimally supervised teams of workers." (AAMA, Technical Advisory Committee, 1988)

2.4 The Push System

The "Push" System - This concept is normally used with "batch" systems in which bundles of work are moved from station to station. Each operator/operation "pushes" all available work forward without regard to work-in-process (WIP) levels at any point. The primary concern is maximizing efficiency at each workstation. This concept is well suited for the production "piecework" compensation system because operators are normally provided large quantities of work to do in a given time allowing the development of high individual efficiencies. The disadvantage of the "push" system is that it tends to generate very high levels of work-in-process and often creates "bottle-necks" in the pipeline as some operations out-perform others. Prior to the implementation of Flexible Manufacturing concepts in the apparel industry, virtually all plants used the "push" system as the sole method of production control.

2.5 The Pull System

The "Pull" System - Each operator/operation performs work only if the subsequent operation in the manufacturing sequence needs a supply according to predetermined WIP levels. When work is not needed at a given operation, operators at the previous operation are idle or move to another operation on which work is needed to be done. The primary emphasis is on maintaining a given WIP level to achieve faster throughput times. This concept is not used effectively with "batch" systems, but normally is used with single or minimal unit production concepts. The number of units between operations may vary from zero to around ten. The piecework concept does not work well in this plan because operators are often required to change operations in order to affect the specified levels of work-in-process between operations. Also, there is occasionally a short period of waiting time prior to receiving or sending work to adjacent operations.

2.6 Hand Off

Hand-Off - Similar to a relay race, each production operator completes a task and passes that garment on to the next person. In the ultimate case, no product is ever idle' but is always being processed by one of the operators. Normally there is only one garment between operations.

2.7 Kanban

Kanban - Using a marked space at each workstation, operators are authorized to work only if the marked space at the subsequent workstation is empty. In some cases a ticket system is used rather than the marked space on the workstation. The applicable theory is that there is no need to provide more product for the subsequent operation than is needed at that time. This is an example of the Just-In-Time concept applied to the individual workstation. It is similar to the Hand Off concept except that some small WIP levels are maintained between workstations to prevent stoppage of the entire line in the case of downtime at any workstation.

2.8 Bump Back

Bump Back - The Toyota Sewn Products Management System (TSS) is credited with creating this concept in which a production operator is replaced at any point in the cycle with the subsequent operator who has just finished a cycle. Each person moves to a previous operation within a specified range of operations. In this manner, a single garment never stops moving and through-put times virtually equal to the actual labor content value can be achieved.

3.0 Flexible Work Group Objectives

When considering a change to Flexible Work Groups, the manufacturing organizations must first define the objectives of the change. It is also important that once defined, these objectives must be listed in order of priority. The twelve United States companies visited in the Clemson Apparel Research study were asked to list in order of priority the three most important objectives for the Flexible Work Group installation. The following is a summary of these objectives ranked in order by the number of responses:

Priority	Objective	Number of responses
1	Increase Productivity/Cost Reduction	9
2	Quick Response	8
3	Improve Quality	7
4	Employee Involvement/Participation	5
5	Savings in Floor Space	2
6	Reduction in Work-In-Process	2
7	Innovation/Trend Setting	1

Once these objectives have been defined, then the type of Flexible Work Group units and the actual configuration can be determined. Decisions can then be made as to whether the Flexible Work Group should be stand-up or sit-down, and whether the handling unit system should be in small bundles, single-piece hand-off, Kanban, or bump back. Also, levels of work-in-process, amount of equipment and actual layout can then be determined. Without a clear understanding of the prioritized objectives from all involved in the decision, it is difficult to answer the numerous policy and procedure questions that will arise during and after implementation. For example, if a fast turn of a few minutes per garment is desired, then the company might choose a stand-up module, using the bump back method, with a machine to operator ratio of 4 to 1, and with a work-in-process level of 1 or 2 pieces. If, on the other hand, a reduction in cost or a savings in floor space are the priority objectives, then the company might choose a sit-down module, using the hand-off method, with a machine to operator ratio of 1.5 to 1, and with a work-in-process level of 10 to 12 units between operators. Improvement in quality, attendance and turnover are the primary objectives, the plant might emphasize the employee empowerment characteristics of a team system which will create a higher regard for the finished product and will offer more job fulfillment for the production workers. It was surprising to see that many apparel manufacturers entered into a Flexible Work Group implementation program without having analyzed and prioritized the basic objectives of the program. These manufacturers seldom realized the full advantages of the system.

4.0 Flexible Work Group Training Principals

The training of the production team members and supervisory/management staff is of primary importance in the successful implementation of a FWG. This is implied in the definition of the FWG in that it is indicated that the program should be continuous. It is clear that if the training program ever stops, the process of on-going improvement will also stop. Further, the CAR study documented several examples of companies that stopped their training program only to see the production operation revert back to a progressive bundle system methodology. The training program is necessary to avoid this inevitable shift as production team members and supervisors add WIP to the process in an attempt to avoid delays when a workstation downtime occurs. The additional WIP is will prevent stoppage of the entire line, but will also add to the production lead time. By keeping the WIP levels low and cross training the operators higher productivity, greater flexibility and faster lead times can all be accomplished.

An effective FWG training program must be planned in advance with specific dates set for the training to occur. The subjects and the instructors should be specified. The training plan should be written and posted throughout the facility for all to see. Management must be disciplined to assure that the plan is followed at all times. Most importantly, the training program must be continuous.

Three basic subject areas should be covered in the training program. Individual training sessions should be alternated within the three areas to provide variety to the program.

4.1 FWG Training Outline

4.1.1 Technical

- **Quality principles**, including individual operation specifications as well as the company quality philosophy.

- **Operation training** to develop cross training within the team. Operator compensation must be developed so that there is absolutely no loss of pay by the team members. Ideally, a gain sharing compensation program should be developed which will encourage team members to learn new operations.

- **Basic industrial engineering** including a methods analysis on each operation. The work measurement system should be explained and demonstrated including time study and Pre-determined Methods/Time Systems (PMTS) if they are used in the plant. A general explanation of how production standards are set should be included. The engineering staff should explain how product costing is developed including examples on the styles expected to be made by the team. It is advisable to also include a budget of all cost categories for each style emphasizing the company profit margins. The plant maintenance staff should be used to conduct training on preventative maintenance for all machines used in the team.

The maintenance staff and/or vendor representatives should cover the correct usage of programmable machines if they are used. Ergonomics, safety principles and other engineering related subjects should be covered.

4.1.2 Managerial

- **Production line balancing techniques** will demonstrate how team members must move to different operations throughout the day in order to prevent WIP build-ups and production bottlenecks. The production control department should explain how product scheduling is accomplished.

- **Problem solving techniques** involve specific steps to identify and analyze a problem and then how to go about solving it.

- **The Conducting of a meeting** will provide team members with basic skills of communication so that they can meet on a regular basis without the need for management. This will include preparation of an agenda for the meeting and the roles of the meeting leader, the time keeper and the scribe.

- **Company personnel policies** should be covered by the Human Resources department. There may be some policies such as work schedules and job transfers which do not apply to the FWG team members. In these cases, the specific exceptions must be documented in the company policy manual.
- **Company benefits** should be covered by the Human Resources department. While these are the same as for the remainder of the plant, it is important to include a discussion of all benefits to the team members.

- **The company history** should be explained by the plant manager or company president. It is important that the team members understand the company's purpose for existence, mission statement and objectives.

4.1.3 Behavioral

- **Effective communication and effective listening** training is essential because the team members are expected to work together throughout the day as they attempt to maximize production and quality. This program should include sessions on written, verbal and non-verbal communication concepts. A local tech school is a good resource for this training.

- **Conflict resolution** training is necessary to deal with the inevitable conflicts that will arise within the team. A local tech school is a good resource for this training.

- **Teamwork training** is important to change the culture of the production process from and individual philosophy to one of working as a team member. This will include exercises on developing a consensus rather than operation as an individual.

- **Brainstorming** is an effective tool to use in developing a team culture toward problem solving. It will also help to assure that all team members will participate fully.

5.0 Steps to Succeed at Flexible Manufacturing

Through this research and after visiting numerous plants that attempted the installation of Modular (Flexible) Manufacturing systems, the steps to make the implementation successful have become clear. Each step must be carefully planned and executed to assure success.

5.0.1 Step 1 Analyze Company Objectives

It is not uncommon for members of management to have different goals for the Modules. In one company, the President wanted Flexible Manufacturing to achieve quick response. The V.P. of Human Resources saw teams as a way to expand employee participation. At the same time, the Plant Manager had no intention of giving up management control of decision making and saw the team system as a way of producing varied styles. The Engineering Manager saw the new concept as a way of correcting some loose piece rates.

Other objectives may be: improved quality, reduced turnover and absenteeism, improved employee morale, reduced costs.

It is quite satisfactory for management to have different goals or expectations for the Flexible Manufacturing concept, as long as these goals do not conflict. It is important that the company's goals be listed in order of priority and that any difference of opinions be resolved in advance. To this end, it is necessary to develop a consensus of quantified and prioritized objectives which are in line with the company mission statement as the first step in the conversion to Flexible Manufacturing.

5.0.2 Step 2 Secure a Commitment from Top Management

For the teams to be successful, it is vital that commitment comes from the top. Depending on the organization of the company and who in the company is the "champion" of Flexible Manufacturing, this commitment

from top management may first be a tentative. Senior management might withhold making a solid commitment until all of the details have been finalized.

In most installations, there will come a "day of reckoning"; a time when decisions will have to be made that could determine the success or failure of the team concept. In one company, several of the team members protested vigorously to top management that they were unhappy and wanted out of the process. Since top management was thoroughly involved and had previously made a commitment, he was able to convince the operators to stay on the team and help work out the problems.

5.0.3 Step 3 Select a Steering Committee

It is advisable to establish a Steering Committee, composed of two or three members of management, production workers, office staff, maintenance staff, supervision, etc. This group should represent each plant function. The maximum size of the Steering Committee should be twenty. This committee would be responsible for both formulating plans for start-up and for actual implementation and follow-up. It is important to remember that the planning and start-up process will take a considerable amount of time and effort from the Steering Committee.

5.0.4 Step 4 Conduct Training for the Steering Committee

It is important that all members of the Steering Committee understand the concepts and principles of Flexible Manufacturing. This is a time to discuss paradigms, and the need for flexible thinking. This is also the time to discuss the pros and cons of Flexible Manufacturing. Every subject of concern should be discussed openly with nothing avoided. The entire group should be comfortable with the process before continuing with the next step. It is advisable to visit other plants which have already started the process.

5.0.5 Step 5 Formulate a Plan for Flexible Production

The Steering Committee will be responsible for developing the plan for Flexible production. This will include thinking through the entire process, anticipating problems and making the initial decisions that are vital to success. Typical decisions that will be made by the Steering Committee are as follows:

1. What are the objectives of the company and the reasons for going to Flexible Production Systems?

2. What are the anticipated levels of WIP for the plant and for the individual teams? This can be determined by first deciding how much lead time is required for the production process from initial scheduling through to packaging and shipping. That total time divided by the number of operations is the average WIP level at each workstation.

3. Will the handling unit be a single piece or a bundle? If a bundle system is to be used, how large is the bundle to be?

4. What will be the configuration of the workstations? The final arrangement is best decided by the team members themselves, but the Steering Committee must decide what to recommend to management for the capital expenditures budget.

5. Will the workstations be standing or sitting? Again, this is best decided by the team members themselves, but the Steering Committee should give it some thought relative to the ergonomics question.

6. Are there machine limitations? Is there enough equipment to effectively operate the team realizing that there is usually a 1.2 to 1.0 machine to operator ratio in most modular arrangements.

7. Are any specialty machines required?

8. What is the amount of spare equipment available for covering downtime?

9. What is the procedure for handling repairs within the team?

6. How will the plant cover machine delay within the team?

10. How will the team be serviced with raw materials and by whom?

11. What will be the size of cut lots and how will this differ from production not destined for the team?

12. Will the size of bundle/unit vary over the process? How will this be controlled?

13. Will there be a need for bundle control tickets? If not, how will production be tracked by size, color and style?

14. How will all supplies of thread, labels, linings, buttons, boxes, etc. be provided on a timely basis to the team and where will they be stored?

15. What will be the level of group participation in decision making? What kinds of decisions will be made by the team and which will be retained by management?

16. How will the team cover for absenteeism?

17. What will be the procedure for selecting the team members initially and as replacements are needed? The options include: volunteers, selection by management and selection by the Steering Committee.

18. What will be the criteria for member selection? Options include grouping by efficiency levels, by height in a standing group and by quality record.

19. How will the plant deal with people who may want out of the group? How will the plant deal with the situation when the team/or management wants a person out of the team?

20. What will be the operator compensation plan? Important considerations are:

    pay for first quality only?
    starting base wage?
    transition pay from piecework to a group compensation plan?
    compensation guarantee during start-up?
    procedure for standard and off-standard costs?
    variation for new styles, fabrics, etc.?
    pay for meetings? How often and for how long?
    pay for training and cross-training?
    how will operators with high earnings be compensated?
    effect on payroll procedures?
    team involvement in establishing the pay plan?

21. What will be the training/cross training plan including the schedule and list of instructors?

22. What will be the role of the supervisor in the team program? What are the supervisory responsibilities/job description? What training will be provided for supervision?

23. What will be the quality control procedures? How will this affect team members pay?

24. What is the estimated start-up costs? This will include: moving machinery and supply lines, additional machinery, work aids, and operator/supervisor training costs?

25. What is the long term plan for implementation and the time frame?

5.0.6 Step 6 Get Approval of the plan from Top Management Re-Affirm the Corporate Commitment

It is important that top management commit to the plan developed by the Steering Committee. Typically, management will have reservations about one or more of the decisions made by the committee. Reservations normally center around pay procedures, how to deal with personnel problems and program costs. It is important that the management adjustments to the steering committee plan be made without negotiation. The National Labor Relations Act (NLRA) of 1934 states that it is illegal for management to negotiate with a group of workers unless the workers have been formally organized according to NLRA guidelines.

5.0.7 Step 7 Top Management Meets with the Management Staff to Communicate the Commitment

This is the time when management communicates the corporate commitment to Flexible Manufacturing to the entire management staff. This meeting should include the management staff at all levels, including the first line supervisors in sewing, cutting and distribution, maintenance, quality, engineering, human resources, finance, sales and other management personnel. This is the opportunity to solidify the management staff behind the flexible project. The goals and objectives of the company should be thoroughly discussed and listed in order of priority. The entire staff should be called upon to lend enthusiastic help and support.

This is also the time to clarify to the staff that a change to Flexible Manufacturing is not a quick fix or other gimmick. The conversion to Flexible Manufacturing Systems is a process that will take a considerable amount of time to perfect.

Problems will arise that may be difficult to handle. The management staff will have to be both creative and flexible to insure success. Finally, there should be ample time for questions or reservations from the group. Each of these must be resolved before proceeding.

5.0.8 Step 8 Conduct Classroom Training Sessions with the Management Staff

It is recommended that at least three, two hour training sessions be conducted with the management staff to cover the basic of Flexible Manufacturing. These classes could be held over a two or three week period. Typical subjects would include flexible concepts, team building, communications, problem solving, basic engineering, motivation, quality and participate management concepts.

5.0.9 Step 9 Announce to the Work Force

This is a message to the entire work force by top management demonstrating commitment and support. Typically, the company President would make the announcement to the entire factory, informing the work force of the decision to start flexible work units. Emphasis would be given to the company's need to stay current with new technologies and management practices, to be able to compete in today's competitive environment and to build for the future.

It is important that the employees not view the Flexible Manufacturing concept as a trial or experiment. By this time there should be a firm corporate commitment and this must be effectively communicated to all employees. The idea of a trial or temporary experiment can also become a "crutch" and a reason to quit if problems later arise in the group. The fact that the President makes the announcement will communicate to the employees the importance of the project. Consequently, employees will be more eager to participate in this new endeavor.

5.0.10 Step 10 Begin Implementation

According to the plan developed by the Steering Committee, the process must begin in earnest. The corporate commitment must be demonstrated by the actions of all management. The training program must be followed as written with deviations only on rare occasions. Follow-up by Management and the Steering Committee should be continuous.

6.0 Selection of the Initial Team Members

6.1 The Interview Process

The interview process is extremely important and will take a considerable amount of time. Care should be taken not to abbreviate the process to save time. The theme of the interview process should be positive and enthusiastic. The goal is to "sell" the employee on the benefits of joining the team. At the same time, the interviewers should be realistic and care should be taken not to paint too rosy a picture. It should be made clear

that the process will be hard work and that problems are inevitable. However, with the participation of all team members, all problems can be dealt with in an effective manner.

The concepts of Flexible Manufacturing are sometimes difficult for people to understand. It is hard for most people to conceptualize without first "seeing". A short, three minute video showing real Flexible Work Groups in actual operation is an invaluable tool in helping operators to visualize the concept.

The following is a list of important points to be covered in the interview:

- Team concepts
- Objectives and benefits of Flexible Manufacturing
- The Supervisor's role as a teacher, coach and helper
- Layout and machine configuration of the module
- Duties and responsibilities of team members
  Quality
  Attendance
- Cross-training of team members who will become experts
- Compensation plan
- Participative management concepts
- Selling Points

  Fun and exciting
  - a different approach
  - an opportunity to learn more
  - an opportunity to become more valuable
  - an environment which will unleash new skills and talents
- The long term company plans for the team concept
- This will be hard work and there will be problems to be solved

- Working as a team is new and different. This will be a learning experience for the entire plant. Things might not go smoothly. There will be problems, but we will work them out together.

- Participation is voluntary, but a commitment is final

Selecting the "right" individuals for the first Flexible Work Group is vitally important. The success of the first module will help determine the attitude of other plant operators toward joining future groups. It is imperative that management give ample time and thought to the selection process. There are numerous ways to select Flexible teams, but each person should begin with asking for volunteers from whom the team members are chosen.

6.2 Selection Criteria

Two of the most common methods are as follows:

Method #1 Management selection based on measurable criteria

Criteria One - Operator Efficiency. In this process, all operators in the plant are grouped by efficiency. There is no standard procedure, but the management typically elects operators for its first module in the 90% to 120% range. Depending on the number of operators in the plant, the differential between team members can vary from 5% to 20%. This arrangement allows for the assembly of a team of operators who have a consistent work pace and similar earnings. For companies with variable base rates, it is advisable to use average hourly earnings rather than percent efficiency in order to avoid pay issue problems within the team.

Criteria Two - Operation Skill. The goal is to try to select as many skilled operators as possible for the most difficult jobs. Each of the difficult jobs should be covered from the beginning, then the team can concentrate on learning the other jobs through cross-training.

Criteria Three - Flexibility. This involves operators who have developed a proficiency on multiple operations. The more jobs an operator knows, the better she/he can help the team. In some cases, an operator with broad flexibility will be of more benefit to the team than an operator with only one highly developed operational skill.

Criteria Four - Attendance. Attendance in the module is critical. Absenteeism can be devastating. Although the flexible environment usually has a positive effect on absenteeism in general, poor attendance habits are always hard to break.

Criteria Five - Quality. Careful attention should be given on this issue. Poor quality is often a sign of a sloppy attitude in general. The success of the team could be jeopardized by a poor quality operator.

Criteria Six - Attitude. As an extremely important factor, attitude can affect relations within the team. A person with an abrasive, antagonistic attitude may be a handicap to the entire team. On the other hand, a poor attitude is often a symptom of some other underlying problem. A poor attitude can be the result of boredom, frustration or lack of job satisfaction. A flexible environment can have a positive effect on poor attitudes. Careful judgment should be given to this criteria.

Method #2 Management selects one or two team members who then select the remainder of the team using the same measurable criteria. The goal here is for management to select two outstanding operators. If possible these operators should be natural leaders, or have the potential to develop into leaders. They should be respected among their peers. The two operators are then thoroughly briefed on the concepts of Flexible Manufacturing. If the two operators accept this role, then the operators and management decide on the criteria to be used for selection. The team leaders are briefed on the interview process and are given a list of interview points to cover. A list of eligible operators is also provided. The two team leaders, accompanied by the Supervisor, then interview the next person selected. If everyone is in agreement, then the third member is added to the team. The three members then interview and select the fourth member. This process is repeated until the complete team has been selected.

There are definite advantages and disadvantages to this process: Team members actively participate in the selection process which typically helps to form a bond or commitment within the team. But, the process is extremely time consuming and there may be some reluctance to reject fellow operators.

7.0 Employee Empowerment

Empowering the production worker with the authority to make some or all of the decisions involving the performance of the task is the basic principle which sets the Flexible Work Group concept apart from other manufacturing systems.

In some of the companies surveyed, involving the employees in the decision making process was an extremely low priority. In these companies, management created a different physical system to manufacture the product (the Flexible Work Group), but left intact the same formal, rigid structure between management and the production workers. It is ironic that even in the companies that did not choose to expand employee participation through Flexible Work Groups, the results were still impressive. Reductions in work-in-process and creating a team atmosphere alone will produce desirable results. However, those companies that did choose to empower employees through Flexible Work Groups have and will continue to reap additional benefits as the employees develop and mature through being involved in making some of the decisions on the performance of their task.

Employee empowerment may be defined as creating the climate in which production workers will participate in traditional management decisions. It is seen as an expansion beyond the typical employee involvement programs which include a suggestion box, soliciting ideas from middle management before decisions are made, employing group problem solving techniques, encouraging two-way communication and reviewing strategies before implementation.

To effectively implement an employee empowerment program, the senior management level must focus on identifying and creating conditions that result in participation; not just insisting upon participation. Suggestion boxes are quite common in United States apparel plants, but they are uncommonly used by the employees because insufficient emphasis is provided and because too often employee suggestions are not acted upon adequately by management. Once the decision is made to implement an employee empowerment program, senior management must effectively communicate this decision to all employees. This has become known as "the last top-down decision." Management is emphasizing the idea that from this point further decisions regarding the performance of the task will be made by the production workers themselves. These decisions would include the work station design, the operation method, machine configuration, and sequence of operations. Assistance from all

management, supervision and engineering personnel should be offered, but the decision itself is a responsibility of the production team.

It is important to stress the value of specific knowledge. It is reasonable to assume that the production worker has more knowledge of the actual operation than does a supervisor, manager, or engineer. Therefore, the employee empowerment program simply establishes the climate in which production workers have the authority to make specific decisions and effectively use that knowledge. This is commonly referred to as "lowering the brain line".

The typical organizational chart in a United States manufacturing plant is shaped like a pyramid with a single individual at the top and having full responsibility of the organization with ever increasing levels of management below that individual and the actual production worker at the very lowest level. Somewhere on that organizational chart is drawn a line below which production workers are not required to think. In effect, the production workers are asked to "check their brains at the door" because no thinking will be required. In fact, some farm work employees were originally called "hands" because use of their hands was all that was expected from them. The employee empowerment program removes the "brain line" from the organizational chart and utilizes the full capabilities of all the employees.

Employee empowerment programs have several elements each of which are seen as uniquely important in order for the program to be successful. The management staff must first remove all company paradigms which may prevent the company from making the necessary cultural changes. These will include structural or organizational constraints which, by virtue of their mere existence, may prevent production employees from being involved in decision making steps. Again, it is critically important that senior management effectively communicate this change in philosophy to all company employees. A single manager or supervisor who even implies that this commitment is not complete may prevent the program from being successful.

It is important that the company identify champions of this new management philosophy. These managers, supervisors, engineers, and production workers will show leadership by example and will demonstrate this commitment in the routine performance of their duties. Further, it is important to establish an atmosphere of support, which is an integral element of the Flexible Work Group concept. By eliminating the atmosphere in which each individual is an entrepreneur, production

workers and all support personnel may work together to solve common problems. In this regard, the individual piecework system of operator compensation is considered to be particularly detrimental to the effective establishment of empowered employee programs. Piecework, by definition, establishes an atmosphere of individuality in which each production worker is considered an entrepreneur. It is difficult to create the climate of employee involvement in this atmosphere. An effective methodology to establish this climate is to create joint management-employee problem solving teams in which production workers and staff support people are assigned as members with equal authority and responsibility.

It is also important to establish a mission statement of the employee empowerment program. This statement should be clear, concise and pointed and should involve all employees in its establishment. Every person involved should have an opportunity for a sense of ownership in the establishment of this mission statement which will assist in the creation of the proper atmosphere for employee involvement and empowerment.

Another critical element in the employee empowerment concept is effective training. It should involve managers, staff support personnel, and all production workers. Subjects should include, but not be limited to, effective communication, effective listening, problem solving techniques, ergonomics, industrial engineering principles, line-balancing techniques, effective meeting organization, conflict resolution, success visualization principles, quality principles, brainstorming, preventive maintenance and safety principles.

8.0 Ergonomic Concerns of Flexible Manufacturing Systems

Ergonomics is the applied science concerned with the characteristics of the human body that must to be considered when designing the production work stations so that the body and work station will interact safely and effectively. Repetitive Motion Disorders are illnesses of the musculoskeletal and nervous systems that result from repeated exertion and abnormal positioning of the hand, wrist, arm, back or other muscles over an extended period of time. These painful and sometimes crippling illnesses make up forty-eight percent of all recordable industrial workplace illnesses. The most common occurrence in the Apparel Industry is Carpal Tunnel Syndrome which is an ailment of the wrist in which the

median nerve becomes irritated and ultimately inflamed. This is caused by constant and repeated movement of the wrist in a given motion; quite common on virtually all production sewing operations. Therefore, flexible team production concepts are seen as a solution to the repetitive motion disorder problem in the apparel industry.

A common belief is that repetitive motion disorders have surfaced only within the past few years, but identification of carpal tunnel syndrome was made as early as 1865, long before the appearance of present-day assembly lines. Statistics show that carpal tunnel syndrome is three to five times more frequent in females than males. Women occupy approximately eighty-eight percent of the production operations in the apparel industry.

Another factor on the apparent increase in repetitive motion disorders relates to changes in lifestyle. Most Americans do not perform as much strenuous work as our predecessors. Therefore, the average worker is less capable today of handling manual jobs.

Another theory suggests that advancements in industrial engineering have broken down tasks into minute, highly repetitive movements that have contributed to an increase in the repetitive nature of the job. This is particularly true in the apparel industry.

There is no doubt that Repetitive Motion Disorders have existed for centuries. The reasons that they have not surfaced until recently are probably due to poor statistical evidence, improper diagnosis, and limited communication as well as the significant increase in the repetitive nature of most production operations in the apparel Industry. An effective ergonomic program will minimize the problem by redesigning the workstations to be more compatible with the worker. However, when apparel is produced in a highly repetitive environment, Repetitive Motion Disorders will continue to exist. The industry must address the repetitive nature of the job as well as the ergonomically correct design of the workstations. Each of these factors is effectively considered in a Flexible Manufacturing environment.

The following factors must be considered in an effective ergonomics program:

8.1 Posture

Flexible Work Groups are commonly standing rather than sitting which is the norm in the apparel industry. The issue has to do with operator movement between workstations. When flexibility is the objective and operators will be frequently changing workstations, it is better to remove the chairs and have the operators stand.

Managers must pay careful attention to the placement of the part or parts supplied to the operation in question. While sitting or standing the operator should be able to see everything needed to perform the task with minimal head movement. Avoid twisting or bending motions as much as possible, especially those that require a long reach or with elements that require reaching behind the torso. If the work station is too high the operator can suffer from shoulder and or elbow problems. If it is to low it can easily result in back problems.

For sitting operators, reposition motors that force the operator to sit farther from the work. The same holds true for the position of the treadle in relation to the needle, most operations can be performed more safely if the two are in line with each other.

Most back injuries are caused from improper lifting, however poor seating is the second worst contributor so careful attention should be paid to the type of chair used. Improper or awkward sitting for prolonged periods can even cause problems with body equilibrium. While there are several manufactures of ergonomic chairs, they all should have the same basic features:

- The seat (pan) should have some type of swivel mechanism.
- The seat height should be adjustable.
- The seat angle should be adjustable.
- The backrest should have a lumbar support.
- The backrest should have a height adjustment.
- The backrest distance from the seat should be adjustable.
- The seat and backrest should be padded and covered in a comfortable fabric.

- A good ergonomic chair should be comfortable, it must encourage movement and it should be easily adjustable by the operator.

8.2 Repetition

Avoid short cycle highly repetitive jobs. By combining operations, different muscles have a chance to rest. Flexible Manufacturing Systems normally provide a job rotation policy where the operators can learn different tasks and help reduce repetitive injuries in the process. An exercise program will help strengthen muscles and increase stamina.

9.0 The Follow-up Procedure

The role of the company in follow-up is critical. Regardless of the amount of up-front planning, the intensity of the follow-up will, in many cases, determine the success or failure of the Flexible Manufacturing concept.

To maintain enthusiasm, early success of the teams/modules is critical. It is important to applaud the small wins along the way. Every accomplishment in the module is reason for celebration. The reaching of production, quality, through-put and work-in-process goals, should be recognized and rewarded.

9.1 Standard Follow-up Techniques

1. To maintain work pace and give constant feedback, the engineer should stand in the middle of the team and call out cycle times to the individual team members. In most teams, individual piece rates are not used, but there is still a need for the classical engineering follow-up and data gathering. This technique allows the follow-up person to grade work pace, to spot methods problems, to perform capacity studies, to do cycle checks and bundle timings. This operator feedback and counseling is extremely valuable.

The follow-up engineer may stand in the middle of the team and record completion of finished products. When the team completes a unit, the final operator calls out the quantity to the follow-up person, who records the data on a worksheet. Operation standards are then applied to determine team daily efficiencies.

2. To Teach Line Balancing, a successful technique is periodic spot-checking of WIP levels in the modules by the follow-up person. If there is a problem, or if problems are developing, the team should be stopped and all members should gather for a short meeting. The problem should be discussed and each member should have an opportunity to make

suggestions. In many cases, the team will know the answer. In some cases, the team may already be aware and corrective action may be underway. When the team is not able to fully comprehend the problem, the follow-up person must offer suggestions and solicit a consensus of agreement. In any case, the important point is for the team to learn from the experience. The goal is for the team to anticipate and learn to solve their own balancing problems.

To control WIP levels, another technique for teaching the team is to select one member who will count and record the amount of work between operations twice daily. Team members will rotate this duty weekly. This person is responsible to maintain a given level of units within the module and to coordinate with other team members to achieve that objective.

3. Assign an expert Staff Engineer or other Management person to the team/modules on a full-time basis. Classical engineering work is still required.

4. Assign a full-time Supervisor to the modules, preferably divorcing the Supervisor from other duties.

5. Operators may time study themselves and post 100% standard production goals for each operation.

6. Management may solicit help from other supervisors for methods or quality problems.

7. Management must stress the importance of spontaneous group meetings within the team/module for dealing with a current problem. These meetings should be called by any member at any time and need last only for a few minutes. It is important to develop consensus solutions to these problems.

9.2 Typical Occurrences and Potential Solutions

1. Individual operator work pace may tend to decrease, especially among operators who previously performed above 100% efficiency. One tendency in modules is for the faster operators to subconsciously pace themselves to the previous operation. Through time study follow-up, the team can be taught the necessity of each member working at their full capacity. Then the faster operators will have time available to help out on other operations.

2. Some team members are reluctant to learn to do a particular operation. In many modules, there is usually one operation or machine that is difficult to learn, either perceived or in fact. The other team members may go out of their way to avoid this operation. This will cause tremendous balancing problems and reduced team earnings as well as cause hard feelings among the team members. To avoid these kinds of problems, management must anticipate problem operations and give an adequate amount of initial training. Additional pay should be provided on those operations that are most difficult. Ideally, there should be at least two members that are fairly proficient on each operation.

3. Some team members may try to work on too many different operations. In some cases, several of the team members will have an intense desire to learn all operations. Some members may have a tendency to move around among several operations, even trying new jobs on which they have not had previous training causing actual performance on these operations may be extremely low. The training program should emphasize that each operation should be covered effectively by more than one operator, but it is not necessary for each operator to know every operation. Management must teach and reinforce the concept of team members adding value to the group. Team members must learn how to balance and rotate among jobs, so that each member is producing the most product in the shortest time.

4. Work-in-process levels may get too high at certain operations. This is an indication that the module is not properly balanced. It takes time for team members to grasp balancing concepts. One technique used to force balancing is to determine and communicate a maximum level of work-in-process between operations. When this level is exceeded, the module team must regroup to correct the out of balance situation.

5. Production standards, used to develop productivity goals may not be accurate for particular styles, fabrics or construction. This is the same problem which may occur in the piecework environment, but will normally be less severe in a group pay plan. The solution to this problem is the use of a Predetermined Motion Time System (PMTS) which is a computerized standard data product that will allow the task of each team member to be accurately measured in advance of production.

6. The supervisor may not thoroughly understand flexible concepts and her/his new role as a leader. In a flexible environment the team members must learn new and different skills and this is even more true for the supervisor. To transform the Supervisor from an autocratic "boss"

into a teacher, a leader and a coach takes time, patience and a significant amount of training. An overbearing, dictating Supervisor can stifle or kill a team concept. Continued follow-up by management is required to spot potential problems and a continuous supervisory training program is a necessity.

10.0 Flexible Manufacturing Systems Operator Compensation Options

Flexible Manufacturing Systems have become quite popular in the United States apparel industry in recent years and are looked upon as part of the solution to the problems facing the industry. It is particularly seen as beneficial in improving product quality and timely deliveries as well as employee morale, turnover, and attendance. However, the United States apparel industry has long relied on piecework to track employee production and to determine operator pay. Changing to the Flexible Work Group system will require that paradigm to be broken so that the coordinated team atmosphere can be emphasized. A typical Unit Production System installation in the United States still employs the piecework system for operator compensation, but several companies are now experimenting with group pay plans in order to create a team atmosphere.

10.1 The Individual Incentive System (Piecework)

The Individual Incentive System (piecework) has been the primary method of operator compensation in the United States apparel industry since the early 1800's. In the "cottage industry" approach where workers at home made products for various industries, the method of payment was based upon a certain number of dollars for each unit produced. Mass production apparel factories were set up in the mid 1800's and the production of the garment was broken down into individual operations while the method of payment remained piecework. It became clear that this system provided a high level of incentive for operator productivity and provided a very accurate method of tracking costs.

Although the system has been refined substantially since that time, the basic concept remains intact. The system has served the apparel industry well in that it provides a compensation plan that is directly related to operator performance. It has facilitated a simple and accurate costing system and it serves as a tool for measuring not only operator effectiveness but also total manufacturing plant effectiveness. In addition,

the statistics generated by the piecework system provide valuable information to management for use in scheduling and line balancing.

The most important aspect of the Individual Incentive System, however, is that it provides a method of recognizing and rewarding production workers for exceptional performance. It has been called " the most fair way to pay anyone." Production workers become entrepreneurs and those who have the greatest amount of skill and who are willing to put forth more effort are paid the most money. When the system works well and is properly maintained, it is the best method known for motivating operator productivity. More than 90% of United States apparel firms use the Individual Incentive System as the method of employee compensation in the stitching department.

However, the proliferation of style, new equipment technologies and changes in the labor force have diminished the effectiveness of this system. Style change is a growing reality in the United States apparel manufacturing industry. In a global market, apparel manufacturers in low-wage-rate countries are much more cost effective in producing the basic apparel product. This reality dictates that long production runs of the same product will continue to be a rarity in United States apparel plants. The niche for United States apparel manufacturers may well be short runs of high fashion products. Because the piecework system is based upon the premise that production operators will be allowed to remain on a single operation long enough to establish a high efficiency level, this system is clearly not effective in the style environment that is becoming increasingly common in the United States apparel industry.

Another problem created by short runs of high fashion products is balance within the manufacturing plant. When an operator is allowed to stay on a single operation for an extended time, not only does efficiency increase but performance also becomes much more predictable. Plant management is therefore capable of balancing operations to achieve maximum overall productivity. However, constant style changes within a plant causes an increase in the number of operations performed by each operator, a decrease in individual operator performance and a drastic increase in the role of supervision and management in balancing the overall operation.

The piecework system encourages the production operator to remain on the operation on which there is the greatest amount of skill. This obviously causes a decrease in the net flexibility of the manufacturing operation. Given the obvious need to create an apparel plant environment

in which style and product changes are welcome, the piecework system is clearly no longer effective.

The most important short fall of the piecework system is that it decreases an operator's concern for quality. By definition, piecework encourages an operator to produce the maximum number of units in a given period of time. There is little incentive for the operator to want to produce a high quality product. The only connection to quality in the piecework system is a negative one, in that operators will be forced to repair any defective work that is detected during "on standard" payroll conditions.

Finally, it is clear that the apparel production worker of today is not inclined to work on the production piecework system. Based on Clemson Apparel Research studies, workers are clearly more interested in a job that will allow interaction with fellow employees and one that will provide an opportunity to be involved in the total work place. Piecework is not designed to offer those opportunities.

The Flexible Manufacturing concept seems to address each of the problems facing the apparel industry today. An effective Flexible Work Group or Unit Production System installation is known to provide significantly improved product quality because operators are encouraged to help each other. Because work-in-process levels are greatly reduced, through-put times are diminished from weeks to a matter of hours, and when there is a quality problem, only a small number of garments are to be inspected and repaired. Therefore, cost effectiveness improves in that total manufacturing costs are reduced. This is clearly contradictory to the piecework system, which encourages operators to work as an individual entrepreneur and in a competitive environment.

10.2 Individual Incentive Plus a Group Bonus

This plan involves use of the individual incentive system with a bonus paid equally to each team member for group performance beyond a given standard. Typically, the standard is one of productivity, but finished quality or other measurable criteria may be used to calculate the bonus.

Virtually all of the disadvantages of the individual incentive system remain applicable. The group bonus does provide some minor incentive toward teamwork and the development of flexibility, but as long as the quantity of units produced by an individual is the primary factor in determining that person's pay, *quantity* will remain the primary objective and the other objectives of a Flexible Manufacturing System will not be realized.

10.3 Group Incentive

Clearly, the most common alternative to individual incentives used today in the United States apparel industry is a group incentive system. In its' most simple application, this concept involves adding the piece rates of all the operations performed by a group of operators, counting the number of complete units produced, and dividing the resulting piecework earnings evenly among the team members. This does enhance flexibility in that operators are encouraged to work on any operation that will help add to the number of completed units. However, unless there is also a connection to the quality level of the group, *quantity* will be the primary objective and ever improving quality will be impossible to achieve. Also, the problem of a competitive environment will continue to exist.

10.4 Jump Base Bonus

As an addition to the group incentive system and similar to it's application in the individual incentive system, a Jump Bonus may be applied to the Group Incentive. The bonus is in the form of a given percentage of the base rate which is awarded to the group upon the achievement of certain objectives. These objectives are usually for increased productivity, but may be for other objective factors such as quality, attendance or through-put time.

10.5 Split Group/Individual Incentive

A given percentage of each operator's pay is based on the performance of the team and the remainder is based on individual performance. Because the individual incentive system must be maintained and each operator's performance as well as the group's performance must also be tracked, a real-time data collection system is desirable. In order to enhance the efforts of the team, it is advisable to base the group portion of each person's pay above 60% with the individual portion below 40%.

10.6 Straight Hourly Pay

This concept involves paying all trained operators in the unit a common hourly rate regardless of job assignment or productivity and with no group incentive or bonus.

The obvious advantage of this system, beyond simplicity of administration, is that it allows each operator to concentrate on quality and flexibility without affecting their earnings. Given the indisputable fact that quality, flexibility and timely delivery of the product are the areas in which the United States apparel industry can be globally competitive, the straight hourly pay system is advocated by many who believe a compensation system must not have any connection to productivity.

The disadvantage of this system is that it provides no incentive to the production operators for increased productivity and it does not recognize the inherent differences in the skill and effort levels of individuals within a group. The historically normal approach in the United States apparel industry stresses individual performance and calculates compensation based on individual merit. No doubt, this method encourages individual operators to become highly efficient on a given operation. It is generally believed that a change from an individual incentive system to straight hourly pay will result in a drop of about 30% in operator efficiency. Several examples outside the apparel industry indicate that this is not true. One major textile manufacturer actually indicates an increase in overall productivity after changing from individual incentives to straight hourly pay. There was an initial drop in efficiency and productivity, but after six months productivity rose and has been sustained at a level at least 10% above the average using the individual incentive system.

Until a major United States apparel manufacturer is able to prove success with straight hourly pay, some type of compensation system which includes an incentive for productivity, as well as quality and flexibility, will be required to move the industry away from the individual incentive system.

10.7 Skill Based Individual Hourly Pay, Plus a Group Bonus

In this plan the manufacturer may set a different hourly rate for each team member based on the number of operations each operator can perform at a set productivity level within the given quality requirements. Several different pay classifications may be available to each operator and once certified the operator can maintain the additional pay additive as long as the qualifications remain current. Periodic reviews by the engineering department will confirm the qualifications and will help to maintain an adequate efficiency standard.

Other objective factors may also affect the hourly pay rate. Average quality level, attendance and years of service are easily measured and will provide additional incentives when properly connected to the hourly rate.

Further, the group of operators may be eligible for a bonus based on achieving certain goals such as quality and productivity levels as well as through-put time objectives. Actually, it is more advantageous to make the group bonus more generous than the average hourly rate so that the performance of the team will be enhanced.

The advantage of this system is that it encourages an operator to develop skills and learn to effectively perform more than one operation in the unit. Individual performance does not need to be tracked thereby reducing clerical/payroll requirements. There is no incentive for an operation to over-produce, as the productivity bonus is based on group performance.

Disadvantages similar to the straight hourly system may be minimized with a generous bonus plan based on quality, flexibility and through-put time.

10.8 Clemson Apparel Productivity Share (CAPS) System

With an increasing number of apparel companies switching to the Flexible Manufacturing System concept, there has been a great deal of experimentation on alternative methods of operator compensation. The objective has been to design a system that would encourage operators to work together as team members and to produce a high quality product in a cost effective manner.

Clemson Apparel Research developed the Clemson Apparel Productivity Share (CAPS) System in order to meet the following objectives:

- Encourage product quality
- Encourage operator flexibility
- Encourage better employee - company relationships
- Provide a monetary incentive for increased productivity
- Encourage an atmosphere of teamwork

CAPS is a spreadsheet system that allows the apparel manufacturer and team members to accurately predict in advance of production the amount of money available to the team members and the company for production of a quality product beyond a certain standard level. By a pre-production calculation of these statistics on a particular style, a goal is established for the team members and indirect employees associated with the team. This system operates on a personal computer (Macintosh, IBM, or compatibles) and uses Microsoft Excel or Lotus 123 software.

CAPS assumes that the group of operators assigned to a team would be paid a guaranteed hourly wage for all hours worked. One of the many problems with the piecework system is that production operators lack a clear understanding of what the hourly wage will be beyond the plant's minimum wage structure. By providing a more generous hourly wage, possibly equal to the highest plant base rate or the plant average hourly earnings level, production operators are relieved of the stressful

uncertainty associated with the piecework system. However, the productivity incentives provided through the CAPS concept will allow overall plant production costs per unit to remain acceptable. The idea of a generous hourly wage is essential in order to avoid one of the more serious problems with the piecework system: drastic fluctuations in operator take home pay. A properly motivated production team will, nevertheless, keep production costs in line.

The program is composed of three primary worksheets: direct labor; indirect labor; and main. Beginning with the direct labor worksheet, the first step in using the system is to list the name of the module, the names of the individuals assigned to that group and their rates of hourly pay. CAPS will then calculate the total number of people and the average hourly wage for each module (Figure 1).

A philosophical point should be considered in determining average hourly wages for team members. In addition to this figure being a generous one, it is appropriate that all of the team members should be paid the same amount, as in Figure 1. After all, the message being conveyed is that all of the team members should share equally in the performance of the team's duties. However, a case may be made for assigning different rates of pay for individual team members. The most obvious example here is that the efficiency level may vary greatly among team members. It is certainly possible that some team members may be proficient at several operations, while other team members may know only one operation. Furthermore, a company may want to reward employees for longevity with a higher rate of hourly wage. These and other conditions may fully justify unequal rates of pay for team members. This is a judgment that must be made by plant management. The system allows this capability, as is noted in Figure 2. The system currently provides for five different flexible teams composed of up to 20 operators each. Depending upon individual company needs, the number of modules and the number of employees per module may be customized as needed.

Figure 1

CLEMSON APPAREL PRODUCTIVITY SHARE
Clemson Apparel Research

Direct Labor

Worksheet #1

	QualiTeam	Hourly Wage
1.	Ann Smith	$5.90
2.	Beth Jones	$5.90
3.	Cindy Williams	$5.90
4.	Debra Jacobs	$5.90
5.	Edith Wilson	$5.90
6.	Freda Adams	$5.90
7.	Gloria Raldolph	$5.90
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
	Number of people in module	7
	Average Hourly Wage	$5.90

Figure 2

CLEMSON APPAREL PRODUCTIVITY SHARE
Clemson Apparel Research

Direct Labor

Worksheet #2

	Quality Makers	Hourly Wage
1.	Sheryl Weeks	$6.25
2.	Helen Ward	$6.50
3.	Linda Patterson	$6.85
4.	Virginia Mabry	$6.95
5.	Chris King	$6.75
6.	Frances Holland	$5.95
7.	Inez Grant	$5.50
8.	Pat Emerson	$7.00
9.	Jean Culver	$10.00
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
	Number of people in module	9
	Average Hourly Wage	$6.86

The user would then move to the indirect labor worksheet and list the names of the persons, job titles, wage rates and flexible assignments for all indirect persons involved (Figure 3). Up to ten indirect persons may be assigned to each of the five flexible teams. Again, customization is possible. The objective of this worksheet is to provide for the possibility that indirect persons, such as supervisors, technicians, quality inspectors, and service persons may be allowed to participate in the bonus potential of the modules with which they work. Certainly these persons play a vital role in the productivity of any flexible team. By providing the opportunity for participation in the team bonus these indirect employees will not only have a much greater incentive for improving the productivity of the module, but will also feel more like true members of the team. An important principle of the flexible concept is that all employees (production operators, indirect employees and company management) feel the sense of belonging to the same production team. Monetarily connecting the indirect labor employees to the production team serves to accomplish this objective. This worksheet is, however, optional and may be omitted from subsequent calculations. You will note that module 4 has no indirect persons assigned and the company's bonus share is listed as the remaining portion after the operator's bonus share is deducted.

Also on the indirect labor worksheet you will notice that the amount of money per unit above standard for each indirect person's flexible assignments is posted. This information is obtained from the main worksheet for each module as will be noted.

Figure 3

CLEMSON APPAREL PRODUCTIVITY SHARE

Clemson Apparel Research
Indirect Labor Worksheet

	Employee	Job Title	Wage	Module Assignment 1	2	3	4	5
1.	Ruth Jones	Supervisor	$9.50	1		1		
2.	George Smith	Mechanic	$10.00	1	1	1		1
3.	Judy Williams	Quality	$9.75	1		1		
4.	Mary Spencer	Supervisor	$8.00		1			1
5.								
6.								
7.								
8.								
9.								
10.								

BONUS PER UNIT ABOVE STANDARD

	Mod. 1	Mod. 2	Mod. 3	Mod. 4	Mod. 5
Ruth Jones	$.07		$.08		
George Smith	$.03	$.03	$.04		$.04
Judy Williams	$.07		$.08		
Mary Spencer		$.07			$.09
Operator bonus	$.50	$.55	$.40	0.45	$.50
Company bonus	$.41	$.40	$.52	0.55	$.43
Indirect bonus	$.09	$.05	$.08		$.08

Moving then to the main worksheet, the module name, average hourly wage, and number of people assigned will have already been posted automatically (Figure 4). Having developed the information from the direct and indirect labor worksheets, the user will now post pertinent information having to do with other cost factors that will be used to develop the total manufacturing cost per period and the total manufacturing cost per standard unit.

The strategy involved in the CAPS concept is that knowing direct and indirect labor costs, the user may consider all other cost factors as a percentage of direct labor. These are factors normally known by plant management and are advisable to share with their production employees. Doing so would send a clear message of cooperation from the company and would aid the production employees in developing a clear understanding of the real costs in operating a manufacturing plant.

As a percentage of direct labor, figures for direct fringe, indirect, indirect fringe, overhead and budgeted profit must now be posted. Normally, these factors will not change among flexible teams or upon style changes within the plant. These factors are indicated by the examples on lines four through eight of Figure 4.

Line nine requests the user to post the sum of the direct labor content for all of the operations involved in the team. Similar to the piecework system, this figure is used to calculate the number of units that the team should be able to produce in order to meet standard. While this figure must be accurate, it is much less critical than the individual operation labor content required by the piecework system. Since CAPS includes the sum of all the operations involved in the flexible team, it is less likely to cause constant criticism as in the case of the production piecework system. It is recommended that this figure be developed using a computerized industrial engineering system, offering speed and accuracy of data. It is essential that all of the information for the CAPS program is available prior to actual production. Since time studies are not possible on a new style never having been in production, a computerized standard data system using predetermined time standards is an ideal method of developing the information needed.

Line ten requests the user to post the hours per period to be used in subsequent calculations. Normally this figure would be the total hours in a single work day or a single work week. By posting "1," the system will

develop the subsequent calculations based on a single work hour. Doing so would be advisable in a plant having frequent style changes.

The above information is used to develop the information posted in lines 11, 12, and 13. Line 11 indicates the total manufacturing cost per period. This is valuable information to convey to the production workers in that it serves to provide a greater understanding of the true cost of operations. Line 12 indicates the standard units per period at 100%. This is the basis of all subsequent calculations and indicates the level at which the team must produce in order to be eligible for a bonus. In other words, as seen in Figure 4, the team of seven operators producing a garment having a labor content of 0.1124 Standard Allowed Hours per piece and working eight hours per day, should be able to produce 499 units "at standard" each day. Production up to 499 first quality units per day would allow the operators to be paid the average hourly wage of $5.90. Any production exceeding 499 first quality units would provide a bonus above $5.90 per hour.

Line 13 indicates the total manufacturing cost per standard unit. This figure is developed (referring again to Figure 4) by dividing the total manufacturing costs per period by the standard units per period.

The theory of the CAPS system is that beyond the productivity level indicated on line 12, all basic manufacturing costs have been met including direct and indirect labor costs, direct and indirect fringe costs, overhead costs and budgeted profit. For production beyond the figure indicated on line 12, the total manufacturing cost per standard unit is the amount of bonus money available to be shared between the company and all the employees. The remainder of the main worksheet is used to determine that share. It is important to note that only first quality units completed and ready for shipment should be considered in determining the quantity produced.

On line 14, the CAPS system initially calculates the actual contribution of the operators as a percentage of the total manufacturing costs per standard unit. Referring to Figure 4, the indication is that 43.0% of the total manufacturing cost per standard unit is contributed by the direct labor employees. This number can be used as a guideline to plant management in determining the share provided for the production team. This percentage is then posted in the indicated cell.

Based upon all of this information, line 15 will then post automatically the operators bonus per unit above standard. Referring to Figure 4, the

indication is that for each unit produced above 499 per day, the team of seven persons would share 97 cents or 13.9 cents per unit per person as indicated on line 16.

Lines 17 and 18 provide the same information related to the company's share. It should be noted that the indirect bonus amount is deducted from the company's portion of the bonus potential. In other words, initially indicating that the operators are to be provided 50% of the bonus earned beyond the production level of 499 units per day, means that the company bonus share is 41.1% and the indirect bonus share is 8.9% as indicated on line19.

Figure 4

CLEMSON APPAREL PRODUCTIVITY SHARE
Clemson Apparel Research
Main Worksheet #1

1. Module name		QualiTeam
2. Average hourly wage		$5.90
3. Number of people in module		7
As a Percent of direct labor:		
4. Direct Fringe		26.0%
5. Indirect		30.0%
6. Indirect Fringe		26.0%
7. Overhead		105.0%
8. Budgeted Profit		6.0%
9. Labor content of entire module - SAH		0.1124
10. Hours per period		8
11. Total manufacturing cost per period		$968.07
12. Standard units per period at 100%		499
13. Total manufacturing cost per standard unit		$1.94
	actual contrib	share
14. Operators' bonus share %	43.0%	50.0%
15. Operators' bonus per unit above standard		$0.97
16. Bonus incentive per operator		$0.139
17. Company's bonus share %		41.1%
18. Company's bonus per unit above standard		$0.80
19. Indirect bonus share %		8.9%
20. Actual Team Production		550
21. Actual Efficiency		110.2%
22. Actual Average Hourly Pay		$6.78

Lines 20 through 22 provide the user with the opportunity of posting actual production figures in order to determine actual efficiency and actual average hourly pay. These lines may be used as examples of certain productivity levels in advance of production or may be used to develop payroll statistics after the production day is complete.

The Clemson Apparel Productivity Share System has been designed to meet the primary objective of providing an alternative to the production piecework system for Flexible Manufacturing teams. There is no doubt that Flexible Manufacturing Systems will play a vital role in the future of the domestic apparel industry. The Individual Incentive System seems inappropriate as a method of operator compensation for a team of apparel workers. CAPS is one of the alternatives available to the apparel industry.

11.0 Flexible Work Group Results

The Clemson Apparel Research study on Flexible Work Groups involved the investigation of cost and benefits statistics at United States and Japanese apparel manufacturing plants that have transitioned from manufacturing using the traditional Progressive Bundle System to a variation of the Flexible Manufacturing System. The information was based upon visits to twelve United States and five Japanese apparel manufacturing companies. A total of 2680 operators on 3204 workstations and operations within 165 modules were involved in the study. These results are summarized in the appendix.

11.1 FWG Quality

All companies in the study upon changing from the Progressive Bundle System reported an improvement in quality as measured both by the number of defects and by customer returns. The average improvement was 65.3%, and ranged from a low of 12% improvement to a high of 97%. Most companies also reported a substantial reduction in the number of irregulars and seconds.

Several companies indicated a drastic reduction in the amount of shortages (i.e., missing parts, lost garments). One company reported that shortages were reduced from about 2% to near 0%, resulting in annual savings of over $250,000.

In most of the companies surveyed, the flexible team was responsible for the quality level of the final product. This responsibility was shifted from an Inspector or Supervisor to the flexible team. Team members were expected to become experts in quality, not only on their operation, but on

all other operations performed within the module. The theory that each function treats the succeeding function as the "customer" is of significant value in the Flexible Work Group concept. The next operation in the module is the "customer" for the previous operator's work and the next module or function is the "customer" for each team. The importance of satisfying the customer is stressed in the continuing training program.

Because most modules produce a complete product, or at least complete components of the product, the idea of ownership becomes a motivating factor. Instead of an operator seeing herself or himself as just a hemmer or just a zipper setter, she or he now becomes part of a team producing a complete product that moves on to the next phase in the manufacturing process.

Peer pressure also plays an important role in improving product quality. Largely dependent upon the method of operator compensation, sloppy operators feel pressure from other group members and are encouraged to do the job right in the first place. If the company's compensation system is based upon the production of only first quality work, the group's output and earnings are directly affected by poor workmanship.

It is important to note that where peer pressure exists, there is also peer support. Where the quality performance of the group is a determining factor in the total compensation, employees tend to help each other by discussing occasional quality problems immediately as they occur. In the Progressive Bundle System/Piecework environment, production operators are actually discouraged from discussing quality problems because it may negatively effect that person's earning potential.

Further, one of the characteristics of Flexible Work Groups is very low levels of work-in-process. If quality problems do occur in this environment, they can normally be spotted and corrected relatively quickly and there is a minimal amount of work to be inspected and repaired. In addition, the defects are not hidden by being tied inside bundles of work as is the case in the Progressive Bundle System.

11.2 FWG Direct Labor Content

The normal expectation is that direct labor content will increase upon the establishment of a Flexible Work Group System. While bundle handling and piecework ticket functions are generally eliminated, this reduction is offset by the time which must be allowed for the movement of operators between work stations. In the Clemson Apparel Research study, direct labor content was reduced by an average of 0.3%. Beyond recognizing the

fact that additional production operator time must be allowed for moving between work stations, most companies also recognized that production labor content was increased because of the performance of various service functions which had previously been the responsibility of an indirect employee.

11.3 FWG Direct Labor Efficiency

In the plants visited, operator efficiency increased an average of 7.7%. There was considerable variation from company to company, with some indicating a decrease and others indicating an increase in efficiency. It should be noted that this increase in efficiency was calculated after any labor content changes were made within the work measurement system. Some companies chose to use this opportunity to correct work content errors so that the garment costing system could be more accurate. Virtually all of the United States companies, and none of the Japanese companies, use an operator compensation system that is based upon the productivity of the group and/or of each individual. This productivity level is typically measured against a production standard that is relevant to an analysis of each production operation. The accuracy of this analysis therefore affects the accuracy of the efficiency statistic. Japanese companies use a compensation system that is based on the profitability of the company over time rather than the quantity of production by the workers.

11.4 FWG Direct Labor Excesses

Another factor which is dependent upon the accuracy of the operation analysis is the resulting effect on excess costs. This factor is normally expressed as a percentage of direct labor and indicates the relative amount of time spent on functions which are "unearned". Depending upon how these statistics are measured and reported, there may actually be an elimination of all excess cost in a Flexible Work Group installation. On average, the twelve companies visited compiled a reduction of 57.1% in total excess cost to an average of 5.7%.

11.5 FWG Net Productivity

By actually comparing the number of units produced by a group of individuals in the Progressive Bundle System versus the same number of individuals producing a like product in a Flexible Work Group, the study was able to analyze the net productivity improvement results. Using this principle as a comparison, the Clemson Apparel Research study has documented a 13.4% increase in productivity of the Flexible Work Group concept versus the Progressive Bundle System. One company indicated that because of this productivity increase they were able to eliminate the

second shift. All of the companies indicated that these productivity increases had led to a substantial reduction in the amount of overtime required.

11.6 FWG Indirect Ratio

The study further documented a significant decrease in the ratio of indirect to direct labor operators. These indirect labor reductions included all functions that have direct contact with the production workers such as supervisor, quality inspector, service person, maintenance technician and repair/cleaning operator. On average, the twelve companies visited indicated a 10% reduction in the indirect/direct labor employee ratio.

11.7 FWG Throughput Times

In regard to total manufacturing throughput times, there is a distinct competitive premium on the ability of manufacturers to respond quickly to smaller, more frequent orders of numerous styles. An effective flexible work group is capable of reducing work-in-process days by an average of 71.1% according to the Clemson Apparel Research study. On average, the plants using the Progressive Bundle System took 14.9 days to complete the product from delivery of fabric to availability for shipping. Of the twelve companies visited, this average was reduced to 4.3 days after the Flexible Work Group system was effectively operating. Many companies sited the ability to turn goods in one day or less if required. Many companies in the survey used Flexible Work Groups to produce samples, first articles and small repeat orders. Three of the companies stated that Flexible Work Groups had enabled them to accept repeat orders for quick delivery that would have been impossible in the Progressive Bundle System.

11.8 FWG Flexibility

Several companies indicated that the smaller module groups made style changes easier. In the Progressive Bundle System, the introduction of a new style can be traumatic, affecting a large number of operators and causing balance problems throughout the production line. With Flexible Manufacturing Units, a new style can be introduced with relative ease, affecting a small number of operators.

In addition, operators in Flexible Work Groups are normally better cross-trained than operators in a Progressive Bundle System, and are likely to have been exposed to more operations. In mature Flexible Work Groups, even drastic changes in construction can be handled fairly easily. To accommodate the new style, operators can be regrouped on the various operations, additional operators can be added as needed, and machinery can be added or replaced as required. To facilitate the changing of

equipment for style changes, it is advisable to install casters on the machines, and quick disconnects for the air and power service.

11.9 FWG Morale

While it is difficult to measure, all companies reported a significant improvement in employee morale. Management cited an accelerated work pace among module members, less time in the break room and rest rooms, and members arriving at work earlier. Module members seemed to feel a sense of ownership through an opportunity to be involved in decision making. In most companies, especially after the first few months, module members indicated that they did not want to return to the bundle system.

11.10 FWG Employee Involvement

Participation in decision making and planning varied from little or none to a high level of involvement. The level of participation seemed to be determined more by the attitude of management than by the maturity of the module. In the companies that did encourage employee involvement, even new team members were encouraged to participate in decisions affecting the group. In those companies, one of the primary tasks of the supervisor was to teach and encourage this type of participation.

In more mature modules, team members decide on when to move for balancing, when more cross-training is needed, and even when to recommend removal of a fellow operator from the group. Other areas of authority may include workstation design, operation method, machine configuration and, in rare cases, group work schedules. In two companies, module members were actively involved in the planning process, making decisions on how to construct new styles and on deciding specific job assignments. Most of the companies indicated that the flexible environment had greatly increased the number of suggestions and new ideas from the employees.

11.11 FWG Direct Labor Earnings Potential

In a progressive bundle system, an operator's earnings potential is normally unlimited. Working on an individual incentive and without regard to work-in-process levels, the only limiting factors are usually the individual operator's skills and desire to perform. In a Flexible Work Group, however, an operator's pay is directly affected by the other team members. Eight companies in the survey paid a group incentive. Three companies paid an individual incentive, with two of these companies incorporating a group bonus on top of individual pay.

Even in Flexible Work Groups that use an individual incentive, individual operator earnings are still affected by the group, at least to some degree. For example, an individual may be required to change jobs more often because of balance problems within the group. Also, absenteeism and quality problems will affect the earnings potential of individuals.

From the study, three companies experienced a significant drop in operator efficiency. This drop was probably due to the leveling effects of the group on individual earnings and by a higher frequency of job changes required in Flexible Work Groups. Six companies experienced significant increases in operator efficiencies. Average efficiency gains for the twelve companies surveyed was 7.7%.

A portion of this gain can be explained by the fact that several of the companies surveyed had implemented modules for only a portion of the production. These companies were careful to select average operators, excluding those with extraordinarily high or low efficiencies. This arrangement temporarily avoided the problem that in Flexible Work Groups the group average tends to reduce the earnings of the more efficient workers, and that the group averages are normally reduced because of less skilled low earners. Conversely, peer pressure of the group tends to have a positive effect on mediocre operators, raising overall group efficiency. One common problem noted by apparel manufacturers who are considering a change to the Flexible Work Group concept is what to do about the potential loss in earnings of the "superstar" operator. This is the person who, on the individual piecework system of compensation, is able to develop unusually high efficiencies and earnings and who may be limited in earnings by the other team members who are not as efficient. A simple group incentive system will cause this limitation in earnings, but an effective gain-sharing plan may allow the "superstar" operator to be properly compensated while maintaining adequate concentration on the team environment.

11.12 FWG Turnover

Employee turnover, a critical factor in the United States apparel industry, improved significantly in plants with a properly functioning Flexible Work Group system. The average turnover rate was 30.7% and the companies with effective employee empowerment programs reported even better results. The average turnover rate in plants using the Progressive Bundle System was 50.9%. Unusually high turnover is normally a symptom of some other motivational problem. From the survey it is evident that the Flexible Work Group management concept can help improve morale and correct at least some of this motivational deficiency. Flexible Work Groups

provide individuals with both a sense of purpose and a sense of belonging. In Flexible Work Groups, individuals become an integral part of a team where they are interacting with other workers rather than operating as an individual in a competitive environment. Flexible Work Groups also provide individuals with the opportunity to learn new and more demanding skills and to grow personally as they become increasingly comfortable with the team atmosphere.

11.13 FWG Attendance

Attendance rates, also a critical factor in United States apparel plants, improved after the successful implementation of Flexible Work Groups. For the same reasons which indicated an improvement in turnover statistics, attendance rates were significantly better after a Flexible Work Group installation.

Peer pressure and peer support are also important factors in improving attendance rates. When a member is absent, the entire team is affected. Therefore, there is much less likelihood of an individual absence because of the desire not to "let down" one's fellow team members. Conversely, when a team member comes to work not feeling well, the other team members tend to provide additional support for that person. This condition is very unlikely in the typical Progressive Bundle System environment where individual
piecework is the method of operator compensation. Quite commonly instead of an operator missing the entire work day for a doctor's appointment, team members now tended to come in and work for a portion of the day before leaving. It was obvious that individuals felt an obligation to the team.

11.14 FWG Space Utilization

Average space utilization improved resulting in a savings in floor space of 36.9%, dropping from an average of 110 square foot per operator to 69.4. Most of the savings in floor space was attributed to the drastic reduction in work-in-process levels in the Flexible Work Groups versus levels in the Progressive Bundle System. In addition, machines in Flexible Manufacturing Units were arranged closer together than machines in the Progressive Bundle System. This space utilization savings resulted despite an increase in the machine to operator ratio from about 1.0 to 1 in the Progressive Bundle System to about 1.2 to 1 in the Flexible Work Group plants visited. Some Flexible Work Group systems, such as the Toyota Sewn Products Management System (TSS), advocate a 4 to 1 machine to operator ratio. Actual savings in space utilization resulting from reduced

levels in work-in-process may be off-set by an increase in the machine to operator ratio.

12.0 Summary

Flexible Manufacturing Systems, including Flexible Work Groups and Unit Production Systems, will provide positive results to many of the problems facing the United States apparel industry today. The "Summary of Results" chart in the Appendix will indicate the expected improvement percentages of many measurable cost and production categories. Realizing that the niche for United States apparel manufacturers is in the ability to provide excellent quality and timely deliveries to the product, it is clear that Flexible Manufacturing Systems are viable.

Both Flexible Work Groups and Unit Production Systems will produce attractive results when compared to the Progressive Bundle System. The difference between the two systems is that in the Flexible Work Group concept the management style change is accomplished through training and implementation of employee empowerment principles. In the Unit Production System concept the management style changes are forced by the functioning of the system itself. It is clear then that the measurable improvements in production cycle caused by the Unit Production System, such as reduced labor content and automatic work distribution can be further enhanced by the incorporation of some Flexible Work Group concepts such as employee empowerment programs and group operator compensation plans.

Net productivity increases were 18.4% in Unit Production System and 13.4% in Flexible Work Groups. The reason for this difference is that the Unit Production System obviously creates reduced work content and automatic movement of the work form station to station. In the Flexible Work Group concept, the production operators move themselves and must manually move the work from station to station.

Direct labor content improvement is virtually equal in the Progressive Bundle System and in the Flexible Work Group. There is a reduction in direct labor content in a Flexible Work Group in that operator bundle handling and piecework ticket manipulation is eliminated, but time must be allowed then for the movement of the operators between work stations. Therefore, there is a "washout" of labor content value. In the Unit Production System concept, however, direct labor content is reduced significantly by 9.7%.

The team atmosphere typically created by the employee empowerment program of the Flexible Work Group concept provided an improvement in quality performance of 65.3% versus the 11.1% improvement indicated in the Unit Production System. By installing these employee empowerment programs in the Unit Production System, the full benefit of quality improvements may be realized. The other improvements of the two systems in direct labor excesses, indirect ratio, attendance and turnover statistics and space utilization were relatively equal.

13.0 Conclusions

The Clemson Apparel Research Demonstration Laboratory installation of both Flexible Work Groups and Unit Production Systems have proven that the concepts are of significant value to the US apparel industry. US Army AG415 shirts and other commercial products have been made using these systems for over six years. An average of over one hundred visitors from the apparel industry have visited the facility each month with the primary item of interest being the Flexible Manufacturing Systems. The results indicated in the industry study have been duplicated in the demonstration laboratory.

It is the philosophy of the author that a Unit Production System is purely a mechanization of the Flexible Work Group concept. It follows then that the implementation of employee empowerment programs and other Flexible Work Group management philosophies within the hardware of the Unit Production System will achieve even better results.

The successful apparel manufacturer in the United States must realize that competing on cost effectiveness alone is impossible. Therefore, in order to fully address the categories in which global competitiveness is possible, Flexible Manufacturing Systems must be employed. Both Unit Production Systems and Flexible Work Groups will help to achieve that competitive edge and the effective combination of the two will provide the best results possible.

Appendix A
SUMMARY OF RESULTS

	PBS	FWG	% Improvement	UPS	% Improvement
Net Productivity			+13.4%		+18.4%
Direct Labor Content			-0.3%		-9.7%
Direct Labor Efficiency			+7.7%		+4.6%
Direct Labor Excesses	13.3%	5.7%	-57.1%	8.8%	-33.8%
Quality (% Defective)	7.2%	2.5%	-65.3%	6.4%	-11.1%
Through-put Time (Days)	14.9	4.3	-71.1%	5.9	-60.4%
Indirect Ratio			-10%		-11.8%
Attendance	94.6%	97.2%	+2.6%	95.6%	+1.1%
Turnover	50.9%	30.7%	-39.7%	35.9%	-29.5%
Space Utilization (Square Feet/Operator)	110 ft.	69.4 ft.	-36.9%	78.4 ft.	-28.7%
Sites Visited	30	12		18	
Number of Operators		2680		1069	
Number of Work Stations		3204		1299	
Number of Units		165		30	
Operators Per Unit		16.4		35.6	

Legend: PBS = Progressive Bundle System
FWG = Flexible Work Group
UPS = Unit Production System

APPENDIX B

DR. W. EDWARDS DEMING'S 14 POINTS OF MANAGEMENT

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive, stay in business, and provide jobs.

2. Adopt the new philosophy. We are in a new economic age. Management must awaken to the challenge, must learn responsibilities, and take on leadership for change.

3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.

4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item on a long-term relationship of loyalty and trust.

5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.

6. Institute training on the job.

7. Institute leadership. The aim of leadership should be to help people, machines and gadgets to do a better job. Supervision of management is in need of overhaul, as well as supervision of production workers.

8. Drive out fear, so that everyone may work effectively for the company.

9. Break down barriers between departments. People in research, design, sales and production must work as a team to foresee problems of production and in use that may be encouraged with the product or service.

10. Eliminate slogans, exhortations, and targets for the work force that ask for zero defects and new levels of productivity without providing the methods.

11. Eliminate work standards (quotas) on the factory floor. Substitute leadership. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.

12. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from stressing sheer numbers to quality. Remove barriers that rob people in management and engineering of their right to pride of workmanship. This means abolishment of the annual merit rating system.

13. Institute a vigorous program of education, re-education and self improvement.

14. Put everybody in the organization to work to accomplish the transformation. The transformation is everybody's job.

Appendix C
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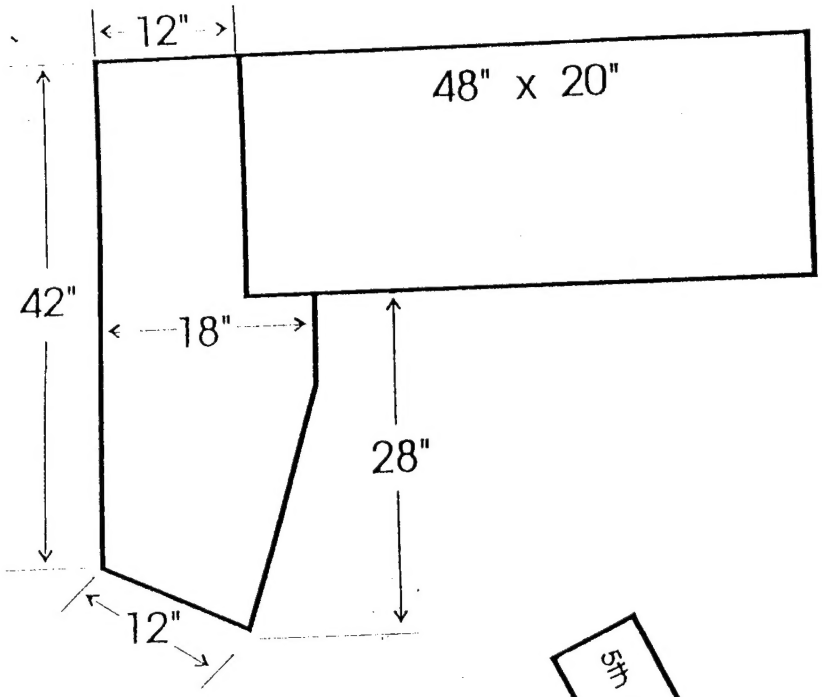
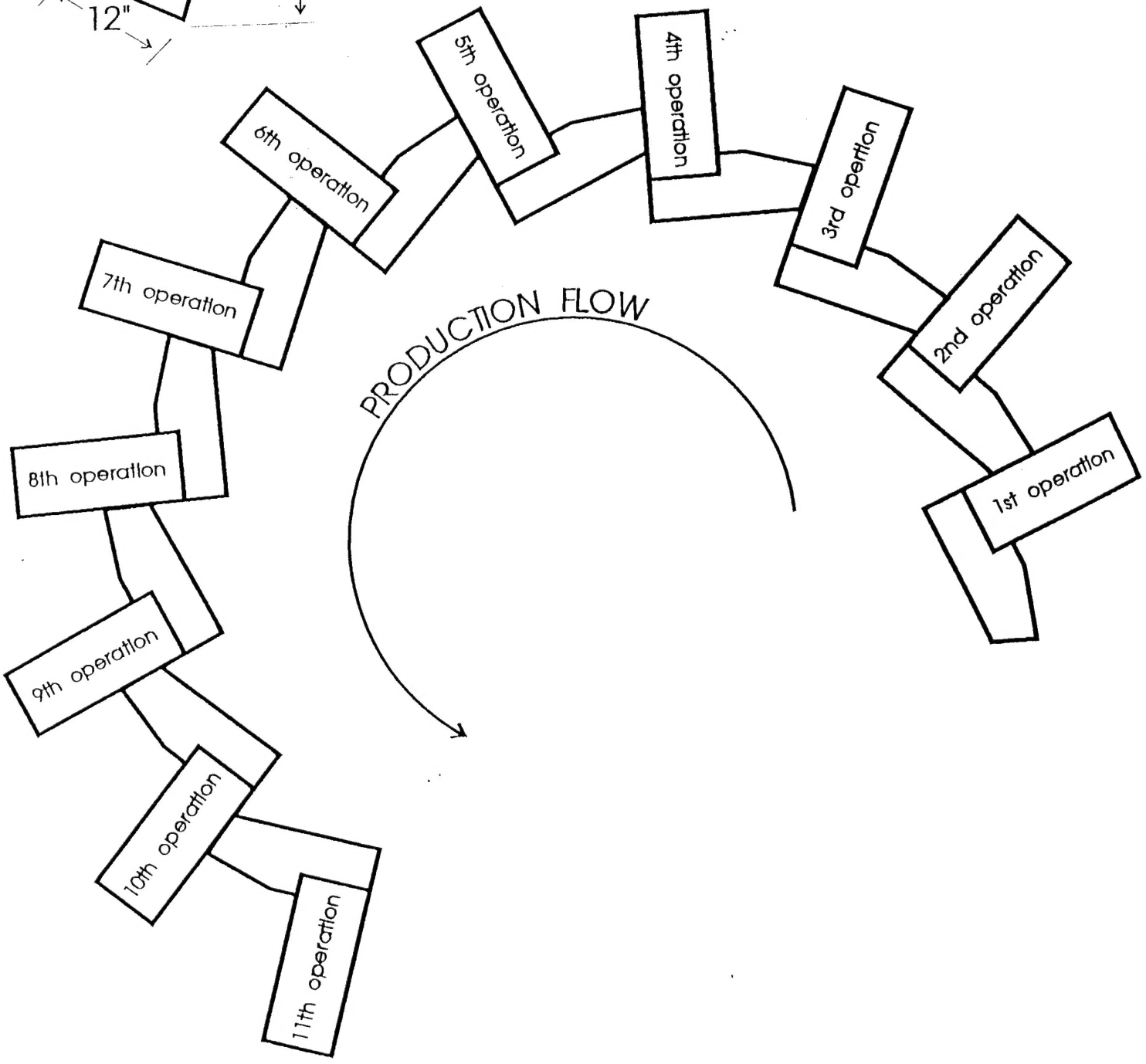
Appendix D
Typical Module Layout





Appendix E
Plant Sites Visited

Flexible Work Group
Sites visited

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Number of Modules (Sewing)	12 (7)	9 (9)	16 (16)	21	6 (7)	3 (8)	4 (20)
Total Workers in Modules	84	81	256	205	42	24	80
Product	Dress Shirts	Shorts/Shirts	House Shoes	Chem-Warfare Hood	Graduation Gowns	Knit Shirts	Jeans
Style or Basic	Basic	Styles	Styles	Basic	Basic	Styles	Basic
Method of Pay	Group Inc.	Ind. Inc	Salary	Group Inc.	Group Inc.	Group Inc.	Group Inc.
Effect on Direct Labor (%)	10 1/2%	8%	0	-6.50%	0	-15%	o
Effect on Efficiency (%)	14%	10%	25%	N/A	36%	-7.50%	-20%
Effect on Excess Costs (%)	4%	-2%	-11%	N/A	0	N/A	-3%
Effect on Productivity	-1%	4%	35.50%	N/A	36%	7.50%	-17%
Indirect Labor Savings:							
# of people	10 people	2 people	4 people	N/A	3 people	4 people	2 people
% of direct labor	-12%	-2.50%	-1.60%	N/A	-7.20%	-17%	-2.50%
work-in-process reduction (days)	7.8 to 1.5 days	8.9 to 0.9 days	20 to 10 days	N/A	30 to 5 days		11 to 3 days
effect on through-put time	-81%	-90%	-50%	N/A	83%		-72%
Improvement on Quality (defects)	N/A	70%	44%	N/A	33%	N/A	73%
Improvement on Turnover Rate	N/A	85%	77%	N/A	0	N/A	60%
Improvement on Attendance	N/A	29%	78%	N/A	0	N/A	N/A
Space Reduction (sq. feet)	33%	30%	51%	N/A	20%	60%	35%

Appendix E
Plant Sites Visited

	Site 8	Site 9	Site 10	Site 11	Site 12	Summary
Number of Modules (Sewing)	5 (12)	10 (20)	2 (14)	37 (20)	40 (22)	165
Total Workers in Modules	60	200	28	740	880	2680
Product	Women's Dresses	Dress Shirt	Polo Shirts Knit Tops	T-Shirts	Women's Shoes	
Style or Basic	Styles	Basic	Styles	Basic	Styles	
Method of Pay	Ind. Inc. w/ Gr. bonus		Group Inc.		Group Inc.	
Effect on Direct Labor (%)	0	N/A	0		0	-0.3%
Effect on Efficiency (%)	11%	-5%	-10%		23%	7.7%
Effect on Excess Costs (%)	N/A	-15%	N/A		-100%	-57.1%
Effect on Productivity	11%	10%	-10%		29.30%	13.4%
Indirect Labor Savings:						
# of people	2 people		3 people		0	-10.0%
% of direct labor	-3.30%		-11%		0	6.3% of Direct Labor
work-in-process reduction (days)	14 to 5 days	14 to 9 days	7.3 to 6.3 days	8 to 0.75 days	14 to 6.5 days	
effect on through-put time	-64%	-71%	13%	91%	54%	-71.1%
Improvement on Quality (defects)	67%		12%	36%	97%	-65.3%
Improvement on Turnover Rate	0		25%	N/A	N/A	-39.7%
Improvement on Attendance	0		22%	40%	42%	2.6%
Space Reduction (sq. feet)	10%	50%	N/A	40%	45%	-36.9%